GENETIC DIVERSITY OF *KAEMPFERIA ROTUNDA* L. ACCESSIONS OF KERALA

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Abstract: Medicinal plants are considered as a rich source of active principles which can be used in pharmaceutical industry. In India, plants have been used for medicinal purposes and have served as the main source of herbal medicines to the rural people and have been used for preventive, promotive and curative purposes. In this context the cultivation of medicinal plants needs more attention to improve the agricultural and rural economy. As a medicinal plant *Kaempferia rotun*da L. is a suitable species for cultivation in Kerala. Selection of promising genotypes having high yield has immense scope in the crop improvement of *Kaempferia rotunda.* With this objective, an experiment for the analysis of the genetic diversity of the species in Kerala State of India was carried out presently based on genetic variability, heritability and genetic advance. Sixty eight accessions of *Kaempferia rotunda* collected from different locations of Kerala State of India formed the experimental material. The study was undertaken at the Department of Botany of University of Calicut, Kerala during 2016-2018. In the first year, sufficient rhizomes were collected from the sources and planted for preliminary study. In 2017-18, an experiment was laid out in randomized block design (RBD) with three replications by adopting standard agricultural practices. Data on fifteen growth and yield characters were recorded by destructive sampling at the end of the experiment and analyzed statistically to study the extent of genetic variability existing in the crop based on these characters. Among the characters studied, the highest GCV and PCV were shown by yield per plant. Broad sense heritability of the agronomic characters ranged from 13.04% to 62.88%. The maximum heritability was observed for yield per plant (62.88%) followed by plant height (62.57%), leaf length (62.52%) and diameter of primary finger (61.11%). High heritability indicates the limited influence of environment on these characters. Highest genetic advance was observed in yield per plant (66.48%) followed by number of secondary fingers (34.69%) and length of secondary finger (24.98%), thus showing the usefulness of these characters in selection programmes.

Key words: *Kaempferia rotunda,*variability, heritability, genetic advance.

I INTRODUCTION

India was known as a rich repository of medicinal plants among ancient civilizations. The forests of India are rich reservoirs of medicinal and aromatic plants, which are largely collected as raw materials for the manufacture of pharmaceuticals and perfumery products. Such plants, especially those used in Ayurveda can provide potential biodynamic molecules of pharmaceutical interest and lead structures for the development of modified compounds with enhanced or reduced toxicity. It is needful to initiate systematic cultivation of medicinal plants in order to conserve their biodiversity and protect the endangered species. Improvement in any species depends on the magnitude of genetic variability and the amount of transmission of characters from one generation to the next (Sujatha and Renuga, 2013). The low productivity can considerably be increased through the use of diverse donor genotypes for various qualitative and quantitative characters. The development of better cultivars by conventional method is slow but identification of superior clones based on phenotypes with high heritability equally expressed in all environments may shorten breeding cycle. Generally plant breeders are particularly interested with diversity at the molecular level (Dempsey, 1996), while farmer's are more concerned with morphological and agronomic variations, which help them to identify superior cultivars that are productive and do well in their location specific environment. *Kaempferia rotunda* is a valued medicinal herb belonging to the family Zingiberaceae. Studies related to its genetic diversity and the stability of its genetic base are limited. This plant requires special attention because it is an important drug in Ayurveda possessing a wide

range of beneficial advantages such as anti microbial (Kumar *et al*., 2015; Dubal *et al*., 2009; Iyenger, 1976; Kabir and Reza, 2014), anti viral (Aznam *et al*., 2012), anti cancerous (Dhanamani *et al*., 2011; Amri, 2014; Tomar *et al*., 2014; Kirana *et al*., 2003; Atun and Arianingrum, 2015), anti-oxidant (Sirat,*et al*., 2001; Pietta, 2000; Middleton, 1984; Chan *et al*., 2008; Atun and Arianingrum, 2015), anti mutagenic (Atun *et al*., 2013) and insecticidal (Nugroho *et al*., 1996; Tushar *et al*., 2010) properties.

Assessment of genetic variability provides the basic foundation for the genetic improvement of the species (Hughes *et al*., 2008). Evaluation and characterization of the germplasm is necessary to identify qualitative and quantitative characters useful for selection programmes. Such studies will assess the genetic variability of the germplasm and find out the quantum of any genetic variability attributable to yield, an essential character to be targeted in all breeding programmes (Virmany *et al*., 1983; Hakim, 2013). Genetic variability and heritability along with the potential for genetic advance in the case of traits, their association and direct and indirect influence on yield are important in crop improvement in order to estimate the heritable and non-heritable variance which will give clues on possible improvement for the characters under study (Rohman *et al*., 2003; Tabasum *et al*., 2010).

The continued commercial exploitation of medicinal plants has resulted in receding of the populations of many species in their natural habitats. This situation demands priority action to conserve the available genetic resources of such species. Genetic variability studies are important in finding out appropriate genotypes for selection and also for other crop improvement programmes. In order to meet pharmaceutical needs and also to prevent the plant from becoming endangered or extinct, it is necessary to conserve and improve *Kaempferia rotunda* for the benefit of the society.

II MATERIALS AND METHODS

Kaempferia rotunda is an aromatic herb with very fragrant subglobose yellow-white tuberous rhizome used in traditional medicine in India. Laterite soil with heavy organic manure application is well suited for cultivation of the species (Joy *et al*., 1999). The present study was carried out in the experimental field of the Genetics and Plant Breeding Division of Department of Botany, University of Calicut, Kerala, India. The experimental garden is located at 75°46' E longitude and 11°15' N latitude at an elevation of 50m from MSL.Preliminary screening of the germplasm was carried out in 2016-17 and the experiment was carried out in 2017-18. The experiment was laid out in randomized block design (RBD) with three replications (Fig. 1).

Sixty eight accessions of *Kaempferia rotunda* collected from different locations of Kerala State of India were used for the study (Table 1). Healthy rhizomes collected from the germplasm developed the previous year were planted in the experimental plot in the first week of May 2017. The rhizomes were separated and each rhizome was planted in 38cm x 35cm polybag filled with garden soil, sand and enriched compost in 3:1:1 ratio. Weeding was carried out and optimum soil moisture was maintained. 2g of NPK (18:18:18) was applied per plant at monthly intervals starting from the 30th day of planting. Growth and yield characters were observed (Table 2) and recorded by destructive sampling at maturity and the data were subjected to analysis of variance (ANOVA) to test the significance of variation (Fisher and Yates, 1963). Phenotypic variance, genotypic variance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (broad sense) and genetic advance were analyzed to study the extent of variation in the case of each character. Phenotypic and genotypic variations of the fifteen characters were estimated as per Singh and Choudhary (1985). Heritability (broad sense), means the fraction of the total variance that is heritable and it was estimated as the percentage of genotypic variance over phenotypic variance as per Chahal and Gosal (2002) and genetic advance as per Singh and Choudhary (1985).

Table 1: Accessions of *Kaempferia rotunda* studied.

Sl. No.	Accession No.	Source	District
1	CUR 1	Kattakada	Thiruvananthapuram
2	CUR 2	Ponmudi	Thiruvananthapuram
3	CUR 3	Kannanalloor	Kollam
4	CUR 4	Aryanadu	Thiruvananthapuram
5	CUR 5	Karunagappalli	Kollam
6	CUR 6	Vakkanadu	Kollam

7	CUR 7	Punnala	Kollam
8	CUR 8	Eraviperoor	Pathanamthitta
9	CUR 9	Manthuruthy	Kottayam
10	CUR 10	Kothanalloor	Kottayam
11	CUR 11	Vadasserikkara	Pathanamthitta
12	CUR 12	Pezhumpara	Pathanamthitta
13	CUR 13	Kurumpanadom	Kottayam
14	CUR 14	Chithirapuram	Idukki
15	CUR 15	Kuttampuzha	Ernakulam
16	CUR 16	Cholathadam	Kottayam
17	CUR 17	Odakkali	Ernakulam
18	CUR 18	Koovappady	Ernakulam
19	CUR 19	Ezhamkulam	Pathanamthitta
20	CUR 20	Pottankadu	Idukki
21	CUR 21	Kuravankuzhy	Pathanamthitta
22	CUR 22	Karumalloor	Ernakulam
23	CUR 23	Upputhodu	Idukki
24	CUR 24	Murickassery	Idukki
25	CUR 25	Erattayar	Idukki
26	CUR 26	Nayyasseri	Idukki
27	CUR 27	Vellathooval	Idukki
28	CUR 28	Thaikkattussery	Thrissur
29	CUR 29	Athani	Thrissur
30	CUR 30	Thathamangalam	Palakkad
31	CUR 31	Mannuthy	Thrissur
32	CUR 32	Kollamkode	Palakkad
33	CUR 33	Nenmara	Palakkad
34	CUR 34	Cherpulassery	Palakkad
35	CUR 35	Mannarkkad	Palakkad
36	CUR 36	Mazhuvanchery	Thrissur
37	CUR 37	Mullassery	Thrissur
38	CUR 38	Chelakkara	Thrissur
39	CUR 39	Amballoor	Thrissur
40	CUR 40	Kavassery	Palakkad
41	CUR 41	Elavanchery	Palakkad
42	CUR 42	Pattambi	Palakkad
43	CUR 43	Mulloorkara	Thrissur
44	CUR 44	Peechi	Thrissur
45	CUR 45	Nilambur	Malappuram
46	CUR 46	Kottakkal	Malappuram
47	CUR 47	Kottukkara	Malappuram
48	CUR 48	Alathiyoor	Malappuram
49	CUR 49	Narippatta	Kozhikode
50	CUR 50	Chempanoda	Kozhikode
51	CUR 51	Avitanallur	Kozhikode
52	CUR 52	Vaduvanchal	Wayanad
53	CUR 53	Kallody	Wayanad
54	CUR 54	Kavilumpara	Kozhikode
55	CUR 55	Nenmeni	Wayanad
56	CUR 56	Thrissilery	Wayanad
57	CUR 57	Peechankode	Wayanad
58	CUR 58	Vengappally	Wayanad
59	CUR 59	Nadavayal	Wayanad
60	CUR 60	Kottathara	Wayanad
61	CUR 61	Ambalavayal	Wayanad
62	CUR 62	Elerithattu	Kasargod
63	CUR 63	Periyanganam	Kasargod
64	CUR 64	Konnakkad	Kasargod

65	CUR 65	Muzhakkunnu	Kannur
66	CUR 66	Aaralam	Kannur
67	CUR 67	Karivelloor	Kannur
68	CUR 68	Edayannur	Kannur

Table 2: Characters observed for the study of genetic variability.

Sl. No.	Characters
Growth characters	
1	Plant height (cm)
2	Number of tillers
3	Number of leaves per tiller
4	Leaf length (cm)
5	Leaf breadth (cm)
6	Leaf area (cm^2)
Yield characters	
1	Yield per plant (g)
2	Number of primary fingers
3	Length of primary finger (cm)
4	Diameter of primary finger (cm)
5	Number of secondary fingers
6	Length of secondary finger (cm)
7	Diameter of secondary finger (cm)
8	Length of mother rhizome (cm)
9	Diameter of mother rhizome (cm)

Figure 1. An overview of the experimental field.

III RESULTS AND DISCUSSION

Genotypic variance, phenotypic variance, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense) and genetic advance with respect to characters of *Kaempferia rotunda* studied are presented in Table 3. Analysis of variance showed that the sixty eight accessions differed significantly for all the fifteen characters showing differences between them at genotypic level.

In the present study, PCV was higher than GCV in all the agronomic characters. Among the yield characters, the highest GCV and PCV were shown by yield per plant. Phenotypic coefficient of variation, genotypic coefficient of variation and heritability (broad sense) of characters can provide an idea of the extent of environmental impact on them, providing an estimate of inheritance of characters that can be expected from parent to progeny which is very necessary in identifying superior genotypes and plant types for agronomic purposes. Broad sense heritability of the agronomic characters ranged from 13.04% to 62.88%. The maximum heritability was observed for yield per plant (62.88%) followed by plant height (62.57%), leaf length (62.52%) and diameter of primary finger (61.11%). The lowest heritability was recorded for number of tillers (13.04%). High heritability of characters indicates that they are influenced by environmental factors to very low extent. Similar experiments have been done in coffee (Nikhila *et al*., 2008) and coriander (Tripathi *et al*., 2000).

The quantum of improvement that is possible under selection can be calculated as genetic advance. It is the ratio between genotypic variance and phenotypic variance (Allard, 1960). The highest genetic advance was observed in yield per plant (66.48%) followed by number of secondary fingers (34.69%) and length of secondary finger (24.98%). Genetic advance was the minimum in the case of number of tillers (6.30%) followed by leaf breadth (11.39%) and number of leaves per tiller (13.04%). These results show that superior genotypes of *Kaempferia rotunda* can be selected based on the agronomic characters like yield per plant, number of secondary fingers and length of secondary finger. Differential variability of quantitative characters in the case of cultivated plants and its application in crop improvement have been investigated and utilized by different workers in crops like coffee (Nikhila *et al*., 2002; Raghu *et al*., 2003; Nikhila *et al*., 2008), ashwagandha (Misra *et al*., 1998), cardamom (Radhakrishnan *et al*., 2006a, b), *Cassia* (Chandramohanan and Mohanan, 2005), *Curcuma amada* (Jayasree and Mohanan, 2006) , wild turmeric (Neethu *et al*., 2017), west Indian arrowroot (Shintu *et al*., 2016), false turmeric (Athira *et al*., 2018) and vanilla (Umamaheswari and Mohanan, 2004).

All the growth and yield characters of *Kaempferia rotunda* presently studied show significant variability indicating the presence of a strong and diverse genetic base for the crop in the study area. However, utilization of this variability both for conservation and improvement of the species is very important since the crop is being marginalized due to utilization of agricultural land for other purposes and changes in cropping pattern.

Table 3: Genotypic variance, phenotypic variance, GCV, PCV, heritability (broad sense) and genetic advance of the characters studied in *Kaempferia rotunda.*

Sl.No.	Characters	Genotypic Variance	Phenotypic variance	GCV (%)	PCV (%)	Heritability (%)	Genetic advance (%)
Growth characters							
1	Plant height (cm)**	81.18	129.75	13.45	17.01	62.57	21.87
2	Number of tillers*	0.06	0.46	8.28	23.45	13.04	6.30
3	Number of leaves per tiller**	0.57	1.94	11.63	21.55	29.38	13.04
4	Leaf length (cm)**	17.95	28.71	11.59	14.66	62.52	18.87
5	Leaf breadth (cm)**	0.46	1.09	8.56	13.10	42.20	11.39
6	Leaf area	889.5	1668.9	16.51	22.62	53.30	24.92

	(cm^2)**						
Yield characters							
1	Yield per plant (g)**	4452.73	7081.21	40.88	51.55	62.88	66.48
2	Number of Primary fingers**	1.78	3.74	15.70	22.79	47.59	22.33
3	Length of Primary finger (cm)**	0.26	0.57	13.46	19.79	45.61	18.59
4	Diameter of Primary finger (cm)**	0.11	0.18	15.49	19.72	61.11	24.82
5	Number of Secondary fingers**	9.25	22.3	26.14	40.58	41.48	34.69
6	Length of Secondary finger (cm)**	0.23	0.49	17.71	25.83	46.94	24.98
7	Diameter of Secondary finger (cm)**	0.04	0.11	14.81	24.44	36.36	18.31
8	Length of mother rhizome (cm)**	0.28	0.57	10.91	15.43	49.12	15.62
9	Diameter of mother rhizome (cm)**	0.09	0.18	11.11	15.56	50	16.02

**Significant at 1% level, *Significant at 5% level.

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